

BIOLOGICAL CONTROL OF NEMATODES WITH PASTEURIA SPP.

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There are numerous micro-organisms that are antagonists to plant-parasitic nematodes. Examples are predatory nematodes (4), nematode trapping fungi (6), and bacteria. Pasteuria penetrans (Thorne) Sayre and Starr (8) is a well known bacterium being tested as a biological control agent of plant-parasitic nematodes. The practical use of biological agents to manage nematode infestations was superseded in the past by the availability of cheaper and more reliable chemical control methods. In recent years, the awareness of the hazards that chemicals pose to humans and the environment and the suspension of several fumigant nematicides, such as DBCP and EDB, has directed the attention of nematologists towards soil-borne nematode antagonists as an alternative method to chemical control practices. Of the multiplicity of micro-organisms that are antagonists, Pasteuria spp. currently appears to have great potential for biological control of nematode pests.

BIOLOGY: An organism closely resembling Pasteuria spp. and parasitizing a nematode was described as early as 1906 (3). This organism, which at first was considered a protozoan, was later recognized as a prokaryote and included in the genus Pasteuria (8). Pasteuria species are obligate parasites and their nonmotile endospores, which are highly resistant to desiccation, attach readily to the cuticle of host nematodes on contact in the soil (Fig. 1). A single nematode may have a few to several hundred spores attached to its cuticle. Later the spores germinate, producing a germ tube that penetrates the nematode's cuticle. In root-knot nematodes this happens most often after the second stage juvenile (J2) has penetrated and become established in the host root. The bacterium grows vegetatively in the nematode pseudocoelom forming branched mycelium. Club-shaped sporangia develop and give rise to endospores, which eventually completely fill the nematode body. A single root-knot nematode female may contain more than 2 million spores (10,12). It is suspected that these spores are released into the soil upon disintegration of the nematode cuticle. The nematode seems to remain alive during the greatest part of the parasite's developmental process. This is evidenced by the fact that infected nematodes continue to develop reaching the adult stage. Eggs generally are not produced by infected females. The total duration of the life cycle of Pasteuria sp. is about 30 days under optimum temperature conditions (12).

SPECIFICITY OF PASTEURIA SPP.: Populations of the bacteria seem to be ubiquitous (9). These organisms were reported from over 135 different nematode species belonging to some 50 nematode genera from a dozen states of the U.S. and from 37 countries on five continents (9). They are common in Florida on some of our most important plant-parasitic nematodes: root-knot nematodes (Meloidogyne spp.) (Fig. 1), lesion nematodes (Pratylenchus spp.) (Fig. 2), citrus nematode (Tylenchulus semipenetrans), sting nematode (Belonolaimus longicaudatus) (Fig. 3), lance nematode (Hoplolaimus galeatus) (Fig. 4), and stubby root nematode

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(Trichodorus spp.) (Fig. 5). The host-range for individual populations of Pasteuria spp. appears to be limited, and isolates specific for many plant parasitic nematodes have been observed (9).

SURVIVAL AND MOVEMENT OF SPORES IN SOIL: Spores of Pasteuria sp. appear to survive long periods under dry, adverse conditions thus giving them the potential for long shelf life. Their capability to attach to the nematode cuticle is not affected by their exposure to variable soil moisture conditions (Oostendorp et al. unpubl.). Pasteuria sp. spores have been noted on root-knot nematode J2 collected from soil 4 feet deep (pers. obs.). Movement of spores with percolating water through a sandy (>90%) soil column was demonstrated under laboratory conditions (Oostendorp et al., unpubl.)

GREENHOUSE AND FIELD TESTING OF PASTEURIA SPP.: The organism was successfully tested in greenhouse and small scale field experiments with promising results in soils infested with root-knot nematodes (2, 5, 13, Oostendorp et al.). The population dynamics of the bacterium in field soil is not yet understood. It has been observed associated with high (11) and low numbers (1, 15) of nematodes. Pasteuria spp. has been shown to be an important nematode suppressive agent in soils in Australia (1), Georgia (7), and Florida (Dickson, unpubl.). As the organism cannot yet be grown on artificial media, inoculum for field testing must be reared on nematodes in the greenhouse (14) or in a nematode-excised root system (16). Neither procedure provides for production of endospores in amounts necessary for large scale studies. A low inoculum level of a Pasteuria sp. specific for M. arenaria was tested in field microplots infected with M. arenaria and planted with peanut and then planted to rye and to vetch winter cover crops or maintained fallow. Over a period of 3 years the Pasteuria sp. increased significantly in plots with rye or vetch compared with fallow. After 3 years the peanut yields were significantly increased in Pasteuria sp. plots compared with plots without Pasteuria sp. (Oostendorp et al. unpubl.).

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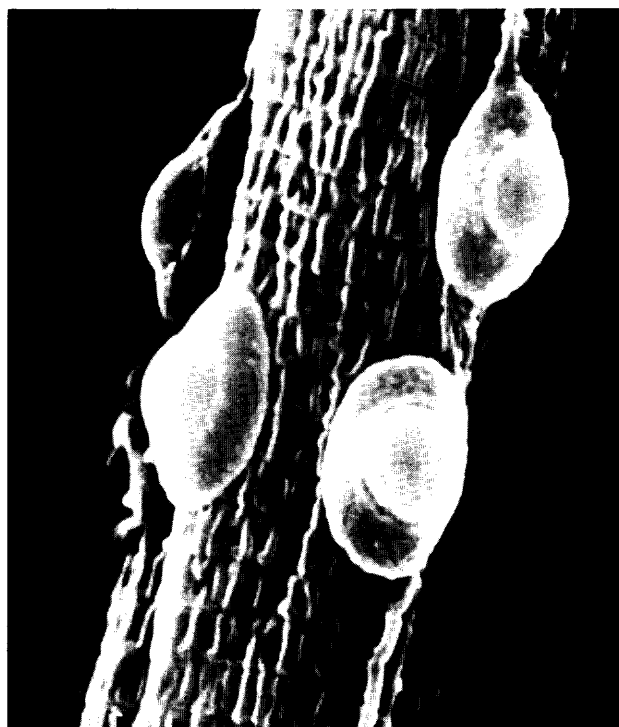


Fig. 1. Scanning electron micrograph of mature endospores of Pasteuria sp. attached to the cuticle of a second-stage juvenile of the root knot-nematode Meloidogyne incognita. (Photo courtesy of N. B. Khuong).



Fig. 2. Photomicrograph of numerous endospores of Pasteuria sp. released from the body of a ruptured female lesion nematode, Pratylenchus scribneri.

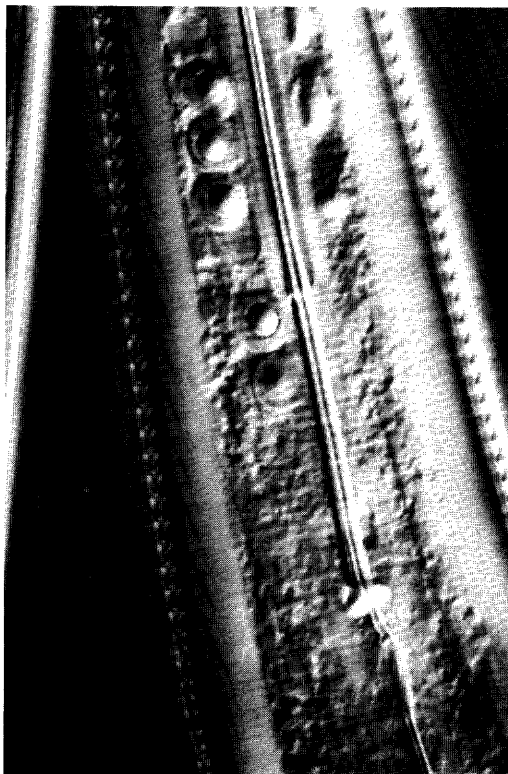


Fig. 3. Anterior section of a sting nematode, Belonolaimus longicaudatus, showing a portion of the stylet and esophageal canal with numerous endospores attached to the cuticle of the nematode.

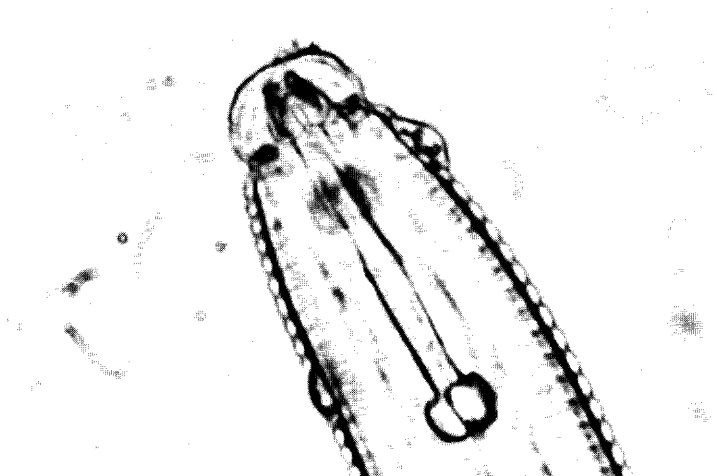


Fig. 4. Anterior section of a lance nematode, Hoplolaimus galeatus, showing the stylet and lip region. A side view of two endospores of Pasteuria sp. are shown attached to the cuticle.

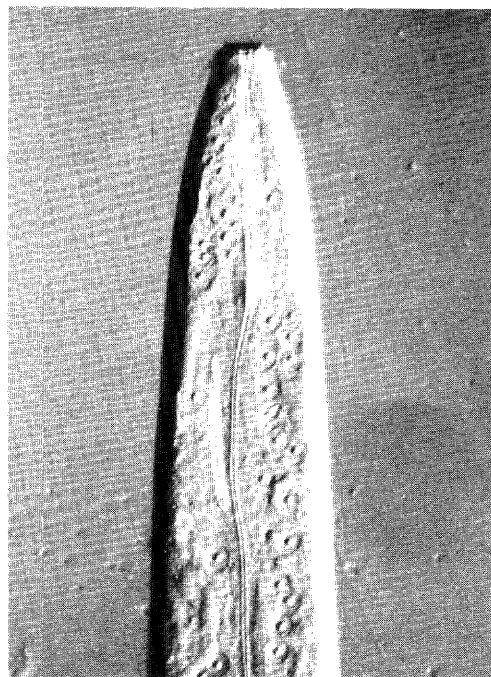


Fig. 5. Anterior section of a stubby root nematode Trichodorus sp. with large endospores in the body cavity.

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